OFFICE OF THE UNDER SECRETARY OF DEFENSE

3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

ACQUISITION,
TECHNOLOGY
AND LOGISTICS

November 7, 2001

MEMORANDUM FOR U.S. MISSION TO NATO, ARMAMENTS COOPERATION DIVISION
Box 200, PSC 81, APO AE 09724

SUBJECT: Draft STANAG 4491 (EDITION 1) – "EXPLOSIVES, THERMAL SENSITIVENESS AND EXPLOSIVENESS TESTS"

Reference document, AC/310-D/179, 28 August 2000, SAB.

The United States ratifies the agreement received under cover reference with reservation and comment.

Ratification and implementation details are as follows:

	IMPLEMENTATION					
	Forecast Date			Actual Date		
RATIFICATION REFERENCE	NAVY	ARMY	AIR FORCE	NAVY	ARMY	AIR FORCE
Memo, OUSD(A&T) DATED AS ABOVE	November 7, 2001			November 7, 2001		

NATIONAL IMPLEMENTING DOCUMENT: MIL STD 1751 (under revision)

RESERVATIONS: See attached DA Form 4797-R. (encl 1)

COMMENTS: See attached DA Form 4797-R. (encl 2)

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Anthony J. Melita
U.S. Key Delegate
AC/310 Main Group

2 encl. as stated

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Reservations to STANAG 4491E1

NO (a)	NATION (b)	PAGE (c)	PARA (d)	LINE (e)	COMMENT(S) (f)	REASON(S) (g)
1	U.S.	C-3-5	Table 2		**RESERVATION:** Add a column to table 2 documenting the test vehicle (i.e., ID, length, tube thickness, type steel). Without this documentation the test results are not very useful	The reaction severity should be influenced by the degree of containment; however, table 2 does not indicate tube size and thus degree of containment is not documented.

REVERSE OF DA FORM 4797-R, DEC 88

Encl 1

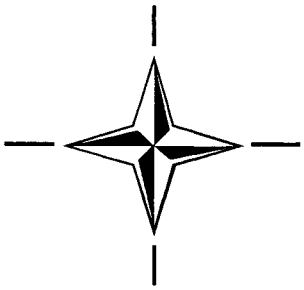
Comments to STANAG 4491E1

NO (a)	NATION (b)	PAGE (c)	PARA (d)	LINE (e)	COMMENT(S) (f)	REASON(S) (g)
1	U.S.	B-2-1	Appendix B2	General	**COMMENT:** the test apparatus and method of temperature measurement is not defined in the STANAG	This is an extremely crude test and the lack of clear definition of apparatus and method of temperature measurement within the STANAG will lead to erroneous data.
2	U.S.	B-2-1	4	3	**COMMENT:** Change to read as follows, " …substances are cut/crushed and then sieved."	PBX samples may have to be cut rather than crushed before sieve.
3	U.S.	B-2-1	6	3	**COMMENT:** Consider changing from 20°C/min to a lesser rate.	20°C/min is a fairly fast rate for an accurate ignition temperature measurement
4	U.S.	C-1-1	2	6	**COMMENT:** Change last sentence to read as follows, " Thermal sensitivity increases with decreasing orifice diameter…"	It is a very awkwardly worded sentence. We assume that the decreasing orifice diameter contains the decomposition gases to a higher degree and in so doing, the time to event and explosion decreases.
5	U.S.	C-1-1	4	3	**COMMENT:** " …substances are cut/crushed and then sieved."	PBX samples may have to be cut rather than crushed before sieve.
6	U.S.	C-1-2	6	5	**COMMENT:** Para 4 and 6 are confusing. Consider re-write.	Para 4, sample preparation, indicates that explosives must be a powder but para 6 allows explosives to be cast or pressed.
7	U.S.	C-2-1	2	2	**COMMENT:** Provide a specific rate for FCO as is done for SCO.	Specific rate insures uniformity of results

8	U.S.	C-2-1	Table 1		**Comment:** How do you get internal temperature? Para 2 and Fig 1 indicate both thermocouples external to the sample	
9	U.S.	C-3-1	6	8	**COMMENT:** Need to add heating rate for SCO	
10	U.S.	C-3-5	Table 2		**RESERVATION:** Add a column to table 2 documenting the test vehicle (i.e., ID, length, tube thickness, type steel). Without this documentation the test results are not very useful	The reaction severity should be influenced by the degree of containment; however, table 2 does not indicate tube size and thus degree of containment is not documented.

STANAG 4491
(Edition 1)

NORTH ATLANTIC TREATY ORGANIZATION
(NATO)



NATO STANDARDIZATION AGENCY
(NSA)

STANDARDIZATION AGREEMENT
(STANAG)

SUBJECT: EXPLOSIVES, THERMAL SENSITIVENESS AND EXPLOSIVENESS TESTS

Promulgated on 28 August 2002

Jan H ERIKSEN
Rear Admiral, NONA
Director, NSA

STANAG 4491
(Edition 1)

RECORD OF AMENDMENTS

No.	Reference/date of amendment	Date entered	Signature

EXPLANATORY NOTES

AGREEMENT

1. This NATO Standardization Agreement (STANAG) is promulgated by the Director, NSA under the authority vested in him by the NATO Military Committee.

2. No departure may be made from the agreement without consultation with the tasking authority. Nations may propose changes at any time to the tasking authority where they will be processed in the same manner as the original agreement.

3. Ratifying nations have agreed that national orders, manuals and instructions implementing this STANAG will include a reference to the STANAG number for purposes of identification.

DEFINITIONS

4. Ratification is "In NATO Standardization, the fulfilment by which a member nation formally accepts, with or without reservation, the content of a Standardization Agreement" (AAP-6).

5. Implementation is "In NATO Standardization, the fulfilment by a member nation of its obligations as specified in a Standardization Agreement" (AAP-6).

6. Reservation is "In NATO Standardization, the stated qualification by a member nation that describes the part of a Standardization Agreement that it will not implement or will implement only with limitations" (AAP-6).

RATIFICATION, IMPLEMENTATION AND RESERVATIONS

7. Page (iii) gives the details of ratification and implementation of this agreement. If no details are shown it signifies that the nation has not yet notified the tasking authority of its intentions. Page (iv) (and subsequent) gives details of reservations and proprietary rights that have been stated.

FEEDBACK

8. Any comments concerning this publication should be directed to NATO/NSA - Bvd Leopold III, 1110 Brussels - BE.

STANAG 4491
(Edition 1)

NAVY/ARMY/AIR

NATO STANDARDIZATION AGREEMENT
(STANAG

EXPLOSIVES, THERMAL SENSITIVENESS AND EXPLOSIVENESS TESTS

Annexes:

A. Thermal characteristics (Small scale, low confinement)
   - A1. Differential Thermal Analysis
   - A2. Differential Scanning Calorimetry

B. Temperature of ignition (Small scale, low confinement)
   - B1. Temperature of Ignition
   - B2. Woods Metal Bath Test

C. Cook-off (Larger scale variable or higher confinement)
   - C1. Koenen Test (FCO only)
   - C2. Variable Confinement Test (FCO and SCO)
   - C3. Tube test (FCO and SCO)

Related Documents:

STANAG 4170 Principles and methodology for qualification of explosive materials for military use.

STANAG 4515 Explosives, Thermal characterization by differential thermal analysis, differential scanning calorimetry and thermogravimetric analysis.

AIM

1. The aim of this agreement is to establish test procedures which provide information on the thermal sensitiveness and explosiveness of explosive materials.

AGREEMENT

2. Participating nations agree to accept these tests as standard procedures for determining the thermal sensitiveness and explosiveness of explosive materials and to use the data exchange formats as indicated in the annexes. One small scale test should be performed from each of annexes A and B, and two larger scale tests from Annex C, one of which is a fast cook-off test (FCO) and one a slow cook-off test (SCO). The small scale tests are performed in order to improve the characterisation of the test explosive and to provide safety information relevant to the handling of small quantities of it and the larger scale tests are performed in order to assist in building a predictive capability in relation to potential systems hazards.

IMPLEMENTATION OF THE AGREEMENT

3. This STANAG is considered implemented by a nation when that nation has issued the necessary orders/instructions putting the contents of this agreement into effect.

A1 - DIFFERENTIAL THERMAL ANALYSIS (DTA)

1. SCOPE

This test is performed in order to determine the onset of reaction temperature of solid energetic materials. The procedure given in STANAG 4515 shall be used.

ANNEX A-2 to
STANAG 4491
(Edition 1)

A2 - DIFFERENTIAL SCANNING CALORIMETRY (DSC)

1. SCOPE

This test is performed in order to determine the onset of reaction temperature of solid energetic materials. The procedure given in STANAG 4515 shall be used.

B1 - TEMPERATURE OF IGNITION

1. SCOPE

The apparatus and test procedure herein described is suitable for the measurement of the ignition temperature of solid energetic materials.

2. PRINCIPLE

Small weighed quantities of the explosive under test are heated in borosilicate glass test tubes placed in a steel block or other suitable heat sink, the temperature of which is controlled to rise at a steady rate of 5°C/minute, until an event occurs.

3. APPARATUS

The test tubes should comply with the following dimensions: length 114 ± 15 mm, external diameter 12-16 mm, wall thickness (light wall) 0.5-1.25 mm with rimmed end. A typical example of the apparatus is shown in Figure 1. Alternative designs may also be used. A hollow mild steel block suitable as a heat sink is wound with a layer of mica insulation and a nickel-chromium heating tape of suitable resistance to provide a sample temperature rise rate of up to 10°C per minute. The block is contained within a metal enclosure packed with thermal insulation. The hollow centre is also packed with thermal insulation. A programmer monitors the block temperature via a Pt/Pt-Rh thermocouple and controls the temperature rise rate. The standard rate is 5°C/minute. A 4.8 mm diameter platinum resistance thermometer is located in a drilling at the same pitch circle diameter in the block as that of the samples. It monitors the temperature at this point and displays it on a digital meter.

4. SAMPLE PREPARATION.

Solid powders should all pass through a 3 mm standard sieve. Rubbery or dough-like samples are either cut into a cube shape of the correct mass or chopped to pass through the sieve.

5. TYPES OF REACTION.

Reaction can take the form of burning with the development of a flame, rapid decomposition (puff of smoke) or explosion.

6. TEST PROCEDURE.

200 ± 2 mg samples of the test material are loaded into glass tubes and inserted to a depth of at least 20 mm into the heat sink. For unknown samples or those thought to be primary explosives a smaller quantity (usually 50 mg) is loaded. Any unused drillings in the block are filled with empty glass test tubes. The temperature controlling programmer is switched on and the sample tubes are observed through the laminated plastic safety screen for any sign of reaction. At least two samples are tested.

ANNEX B-1 to
STANAG 4491
(Edition 1)

7. REPORTING OF RESULTS / DATA-SHEET

The result of the test is reported as a "Temperature of Ignition" and is the lowest temperature at which reaction is observed. If the duplicated samples produce results differing by 3°C or more the test is repeated. Samples which give no sign of reaction up to the usual maximum temperature of the test (400°C) are allowed to cool and then examined. If upon examination no decomposition is apparent the result is recorded as "Not less than 400°C". When examination does reveal decomposition to have occurred the result is recorded as "Decomposes slowly".

8. REFERENCE DATA

Heating rate 5°C/min

Test explosive	Ignition temperature,°C	Reaction type
Lead styphnate	269	Explodes
Service lead azide	319	Explodes
Double base propellants	167	Ignition
AP/HTPB propellant	271	Ignition
TNT	288	Ignition
Tetryl	183	Ignition
RDX	219	Ignition
HMX	273	Ignition
PETN	186	Ignition

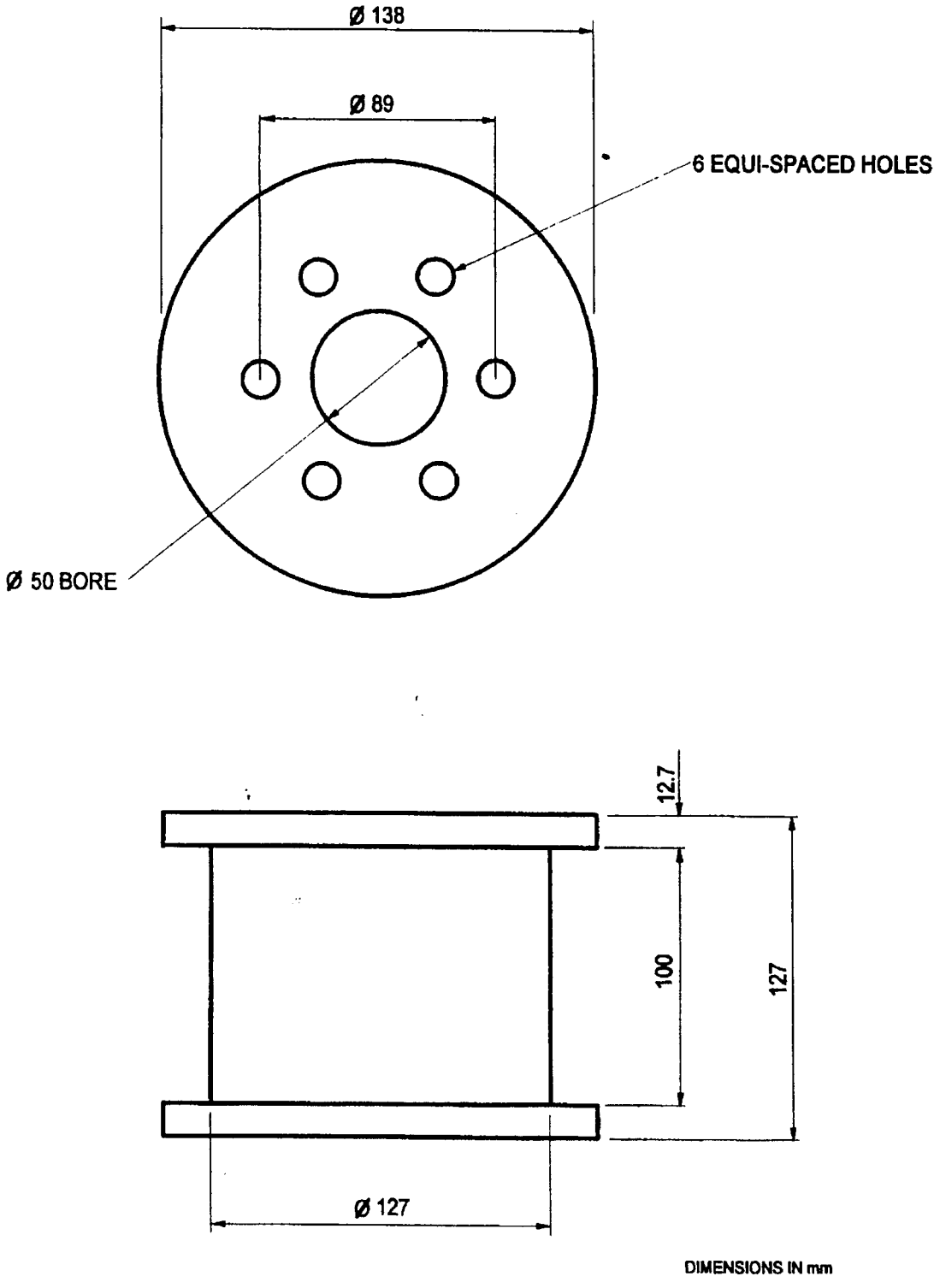
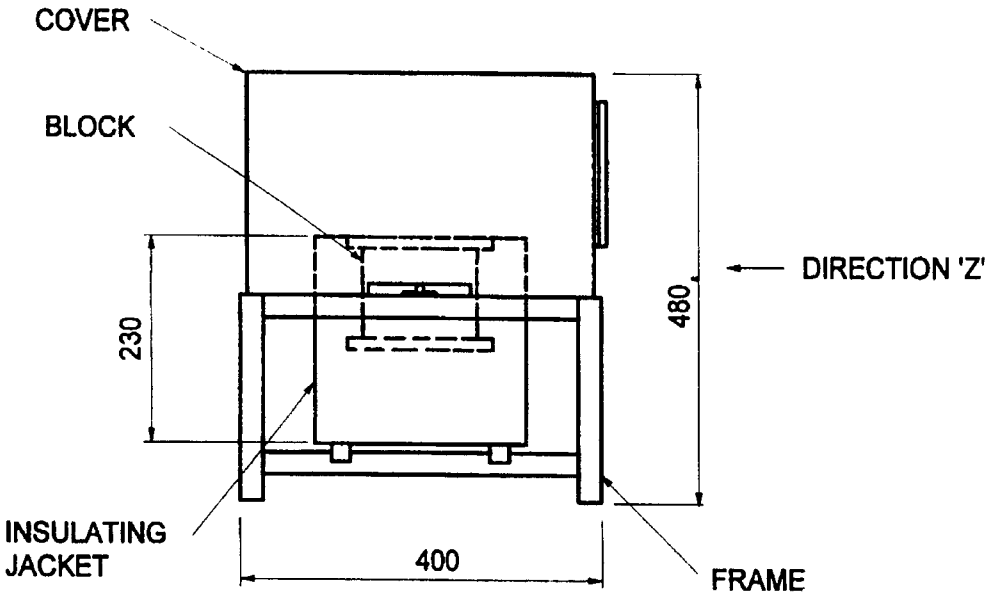
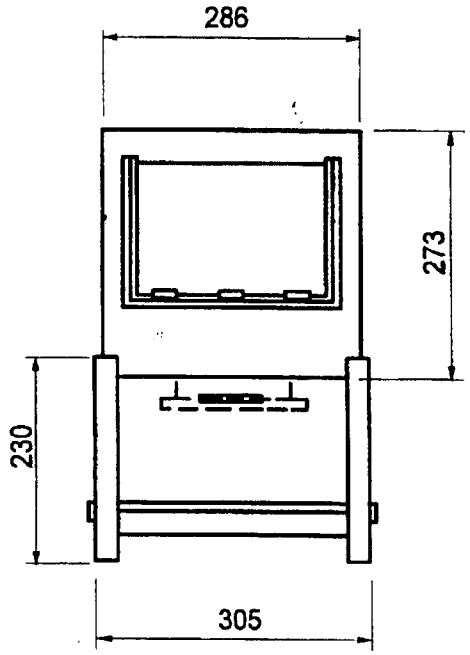


FIGURE 1 - TYPICAL EXAMPLE OF A HEATING BLOCK

ANNEX B-1 to
STANAG 4491
(Edition 1)





VIEW IN
DIRECTION 'Z'

DIMENSIONS IN mm

FIGURE 2 - TYPICAL ENCLOSURE

B2 - WOODS METAL BATH TEST

1. SCOPE

The apparatus and test procedure herein described is suitable for the measurement of the ignition temperature of solid energetic materials.

2. PRINCIPLE

The temperature of a sample of explosive is raised either until it reacts or until a maximum temperature of 360°C is reached.

3. APPARATUS

This consists of an electrically heated oven, Wood's metal, glass test tubes, a stirrer and temperature monitoring equipment. The oven must be capable of heating the Wood's metal at a rate of 20°C/min and up to a temperature of 400°C. The test tubes are of the following dimensions; length 125-130 mm, internal diameter 12 - 15 mm and wall thickness 0.5 mm.

4. SAMPLE PREPARATION

Solid explosive substances are tested in the dry state. Powdered substances are sieved and the fraction with a particle size of 0.5 to 1.0 mm is used for testing. Pressed, cast, or otherwise compacted substances are crushed and then sieved. Small grain gun propellants are tested in the original size. Liquid explosive substances are tested without preparation.

5. TYPES OF REACTION

These are ignition, decomposition, deflagration or explosion.

6. TEST PROCEDURE

0.5g of the test material is loaded into each of three test tubes. The tubes are immersed to a depth of 20 mm in the Wood's metal bath once the latter has reached a temperature of about 100°C. The temperature of the bath is still raised progressively at a rate of 20°C/min to a maximum temperature of 360°C. During this heating process, the temperature at which a change is observed in the samples (ie. smoke, gases, flame) is noted. If there is no reaction up to a maximum temperature of 360°C, this is also noted.

7. REPORTING OF RESULTS / DATA-SHEET

The ignition temperature is reported. This is the lowest temperature at which any ignition, decomposition, deflagration or explosion occurs.

ANNEX B-2 to
STANAG 4491
(Edition 1)

8. REFERENCE DATA

Heating rate 20°C/min

Test explosive	Ignition temperature,°C	Reaction type
Tetryl	201	Decomposition
PETN	207	Ignition
RDX	227	Decomposition
HMX	278	Decomposition
TNT	327	Ignition

C1 - KOENEN TEST (FCO only)

1. SCOPE

The apparatus and test procedure herein described is suitable for the measurement of thermal sensitivity of solid energetic materials.

2. PRINCIPLE

The thermal sensitivity of explosive substances to a strong and sustained thermal stimulus is determined in the steel tube test or Koenen test. Samples of the test material are confined in a steel tube fitted with an orifice plate at the top end. The tube is heated by four propane burners and both the time to and nature of any ensuing reaction is noted. Most explosive substances will demonstrate a change from a burning response to an explosion response at a limiting orifice plate diameter and explode at all smaller orifice diameters. Thermal sensitivity increases with increasing limiting orifice diameter and decreasing time to event and time to explosion.

3. APPARATUS

The apparatus is shown in Figures 1 and 2. It consists of a protective steel box fitted with the four propane gas burners, three in the walls and one in the base, each set up so that the tip of the inner blue flame just touches the tube and each heating a different part of the tube. Also there are two 4 mm support rods, the steel tube and the orifice plate. The 24 mm internal diameter, 75 mm long steel tube is drawn from sheet steel and a flange at the top seals against a selected chrome steel orifice plate. These components are held together by a threaded collar and box nut. The threaded collar and box nut are made from manganese chrome steel. Plates with an orifice diameter of 1, 1.5, 2, 2.5, 3, 4, 5, 6, 8, 10, 12, 14, 16, 18 and 20 mm can be used. The protective box is located in a test chamber which can be viewed though an armoured glass window in a strong wall.

4. SAMPLE PREPARATION

Solid explosive substances are tested in the dry state. Powdered substances are sieved and the fraction with a particle size of 0.5 to 1.0 mm is used for testing. Pressed, cast, or otherwise compacted substances are crushed and then sieved. Small grain gun propellants are tested in the original size. Liquid explosive substances are tested without preparation. Composite rocket propellants are cast directly into the steel tube.

5. TYPES OF REACTION

These range from an undamaged tube to the whole tube assembly being damaged or fragmented. It is possible to sub-divide the types of reaction into nine categories as follows:

- : Tube undamaged
A : Tube bottom bulged
B : Tube bottom and wall bulged
C : Tube bottom severed
D : Tube torn open
E : Tube split into two fragments
F : Tube split into three or more mainly large fragments
G : Tube split into many mainly small fragments
H : as G; threaded collar, box nut and/or orifice plate damaged or fragmented

For the purposes of this test only F, G and H are positive reactions.

6. TEST PROCEDURE.

Solid, liquid or gelatinous substances can be tested. Each trial involves the filling of a tube to a depth of 60 mm, ie. 15 mm from the top of the tube. The empty tube is weighed. Powdered substances are lightly tamped using a wooden rod and by tapping on the outside of the tube. Gelatinous substances are incrementally loaded into the tube using a spatula and light tamping with the wooden rod. Explosive substances can be tested in a compacted state by either casting or pressing directly into the tube or by machining to the tube dimensions.
The tube is re-weighed, then fitted with an orifice plate and the nut assembly fitted and tightened. It is then suspended between the two supporting rods in the protective box, the pilot flame is ignited and the door to the test chamber is closed. The burners are ignited and the time (t_1) between ignition of the burners and the first reaction of the sample is noted. If the first reaction is not an explosion, the further time elapsed between t_1 and explosion (t_2) is noted. Should an explosion not occur, t_2 is the time from the first reaction of the test substance to its total consumption. After each test the gas is turned off and the chamber is ventilated. Then the steel tube or its fragments are collected for inspection. All subsequent tests are performed at the same sample density as was involved with the first test.

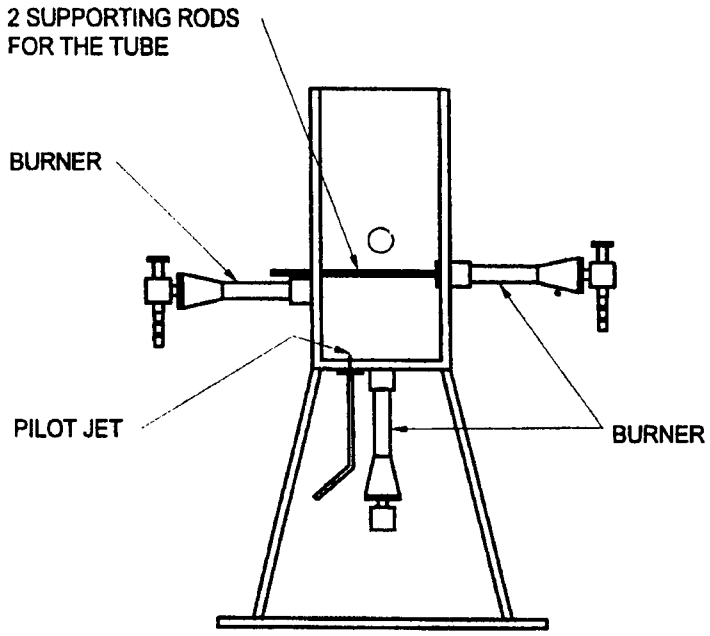
7. REPORTING OF RESULTS / DATA-SHEET

The thermal sensitivity of an explosive substance is expressed as the orifice plate limiting diameter; that is the largest diameter giving at least one explosion in three trials. Explosion is defined as those events causing the steel tube to fragment into three or more pieces.

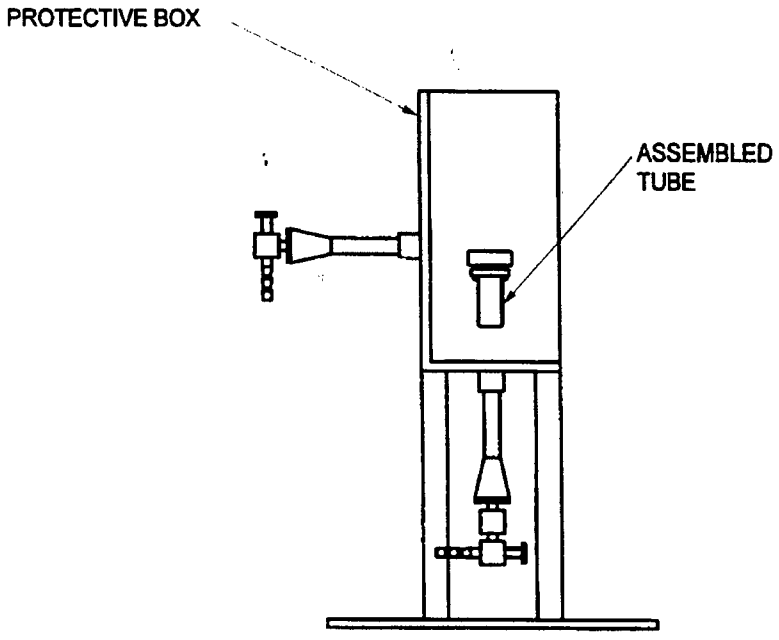
8. REFERENCE DATA

Formal pass / fail criteria are not applied to the test results. Measurements of t_1 and t_2 are only used to differentiate between two explosives if they have the same limiting orifice diameter.

Test explosive	Limiting orifice diameter, mm	Reaction category
TNT	4	F
PETN	5	G
Tetryl	6	G
RDX	6	G
HMX	8	F



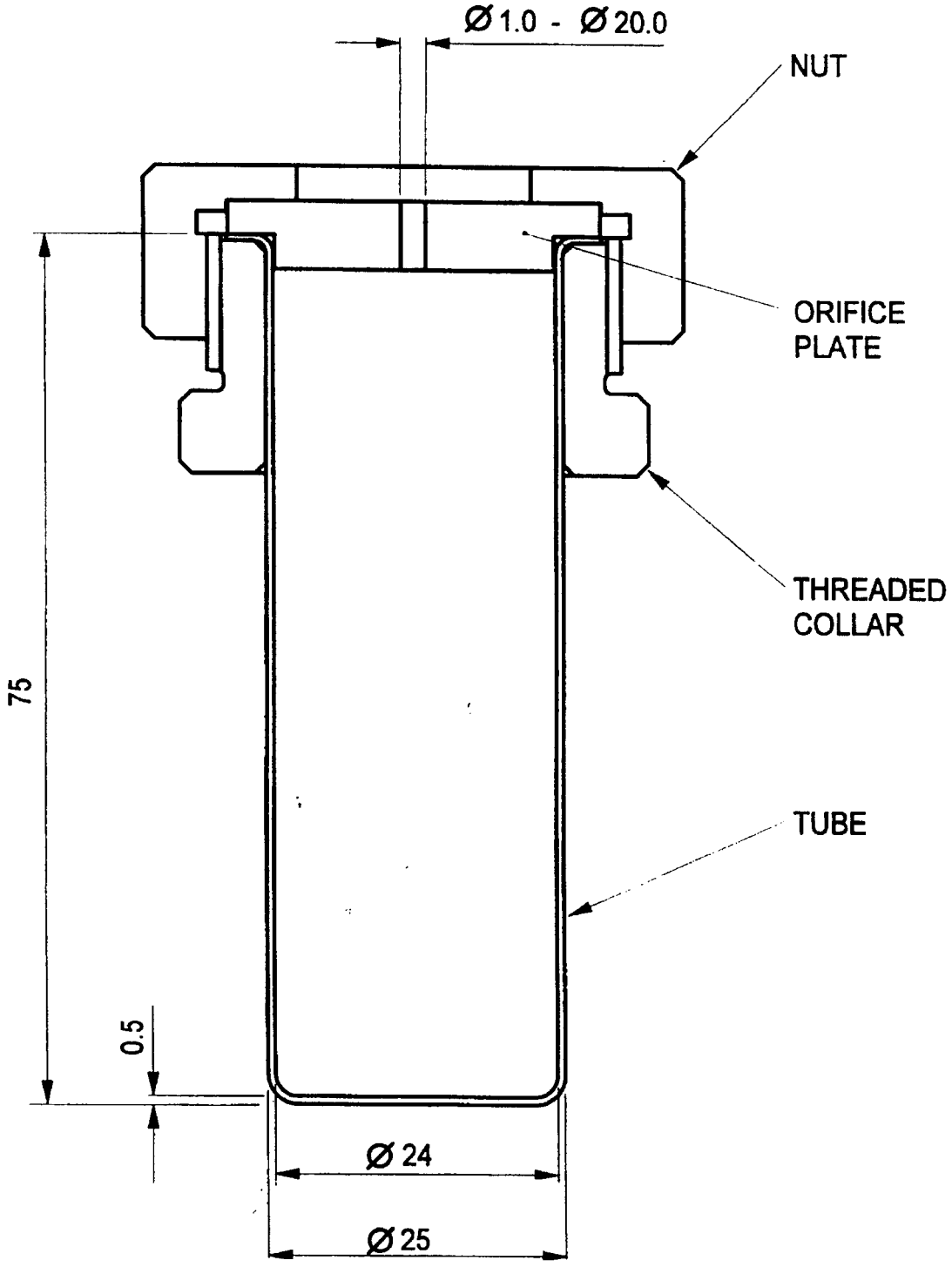
FRONT VIEW



SIDE VIEW

FIGURE 1 - TYPICAL HEATER ENCLOSURE

ANNEX C-1 to
STANAG 4491
(Edition 1)



DIMENSIONS IN mm

FIGURE 2 -TUBE AND ACCESSORIES

C-2 - VARIABLE CONFINEMENT TEST (FCO AND SCO)

1. SCOPE

The apparatus and test procedure herein described is suitable for the measurement of the explosiveness of solid energetic materials.

2. PRINCIPLE

A sample of explosive, confined in an aluminium liner within a steel tube, is heated by means of electrical windings. A typical fast cook-off heating rate is shown in Figure 1. Slow cook-off rate is 3.3 °C/h. The degree of tube fragmentation is used to determine the reaction category and the objective of the test is to determine the median tube thickness just resulting in a deflagration reaction rather than burning.

3. APPARATUS

This is shown in Figures 2 to 7 and consists of an aluminium liner, one from a series of increasing wall thickness steel tubes, heating bands, thermocouples, steel spacer washers, steel end plates and retaining bolts. The thickness of the aluminium sleeve is 2.5 mm and the thickness of the steel tube can be 0.375 to 3 mm in 0.375 mm increments. Two thermocouples are fitted, one in each of two diametrically opposing grooves in the aluminium sleeve. Either two mica-insulated band heaters or an insulated nichrome wire winding are located on the steel tube, spacer washers are added to each end and the assembly is located in recesses between steel witness plates. The retaining bolts are evenly tightened to a torque of 40.7± 4Nm.

4. SAMPLE PREPARATION

Each explosive sample weighs approximately 50 g and can consist of a single piece or three pellets.

5. TYPES OF REACTION

Burning: The steel sleeve is recovered in one piece. The aluminium sleeve is usually recovered in one or two pieces. Witness plates exhibit no deformation. Retaining bolts usually remain intact, although in some cases they may be bowed.

Deflagration: The steel sleeve is recovered in one or two pieces. The aluminium sleeve usually fragments into large pieces. Witness plates exhibit slight deformation. Retaining bolts fail in shear.

Explosion: Both steel and aluminium sleeves fragment into several large pieces. Witness plates exhibit some deformation.

Partial detonation: Steel and aluminium sleeves fragment into both large and small pieces. Witness plates exhibit severe deformation.

Detonation: Steel and aluminium sleeves fragment into very small pieces. Witness plates exhibit severe damage.

Cautionary Note: In the French language the terms 'deflagration' and explosion' are used in the opposite sense to the definitions given above. In the French version of this STANAG in English the word 'deflagration' is translated as 'explosion' and the English word 'explosion' by the French word 'déflagration'.

6. TEST PROCEDURE

A starting confinement thickness of steel tubing is chosen and a test vehicle is prepared. The temperature of the curved surface of the test explosive is raised at the prescribed rate as judged by the thermocouple outputs until reaction occurs. Following reaction, all debris is collected and assessed. Testing continues by altering the steel confinement thickness, until the transition region from a burning to a deflagration reaction has been first bracketed and then confirmed by a number of results on each side of the transition. If it is not possible to determine the burning to deflagration transition because, for example, the response is more violent even when under the lowest confinement level, then the trials results are recorded and reported as they stand.

7. REPORTING OF RESULTS / DATA-SHEET

The reaction categories of all of the trials conducted are reported and the steel confinement thickness to cause a transition from burning to deflagration is calculated.

8. REFERENCE DATA

These are shown in Table 1.

TYPICAL FAST COOK-OFF PROFILE

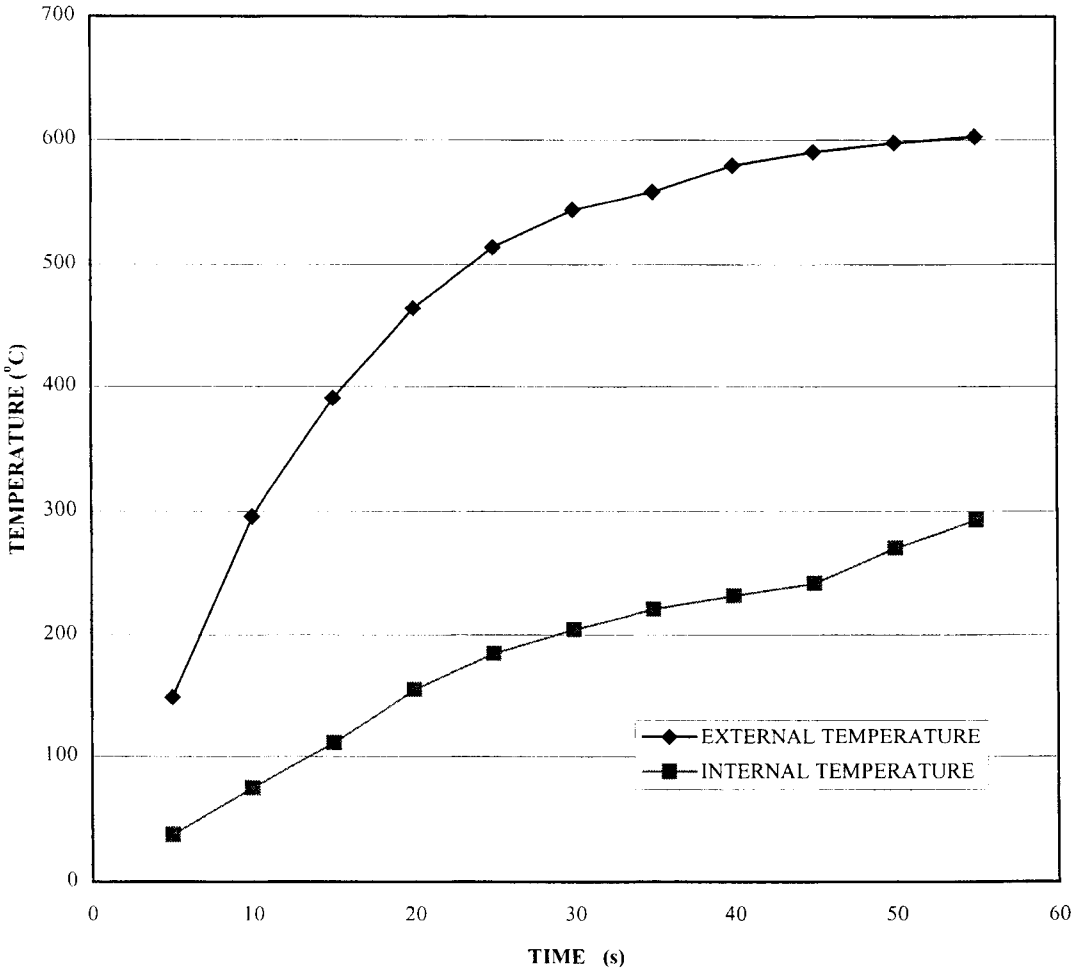


FIGURE 1

ANNEX C-2 to
STANAG 4491
(Edition 1)

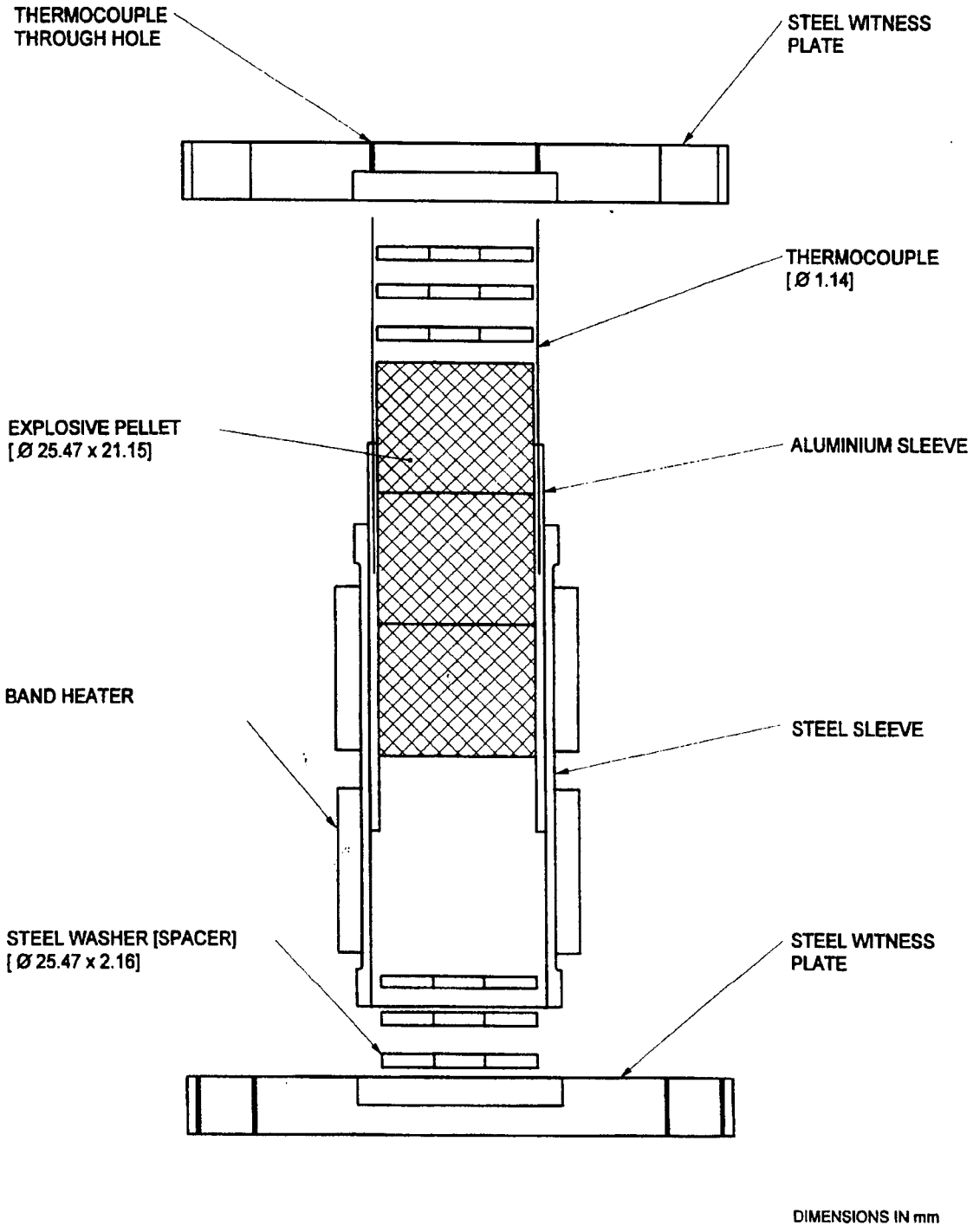


FIGURE 2 - ASSEMBLY, EXPLODED VIEW

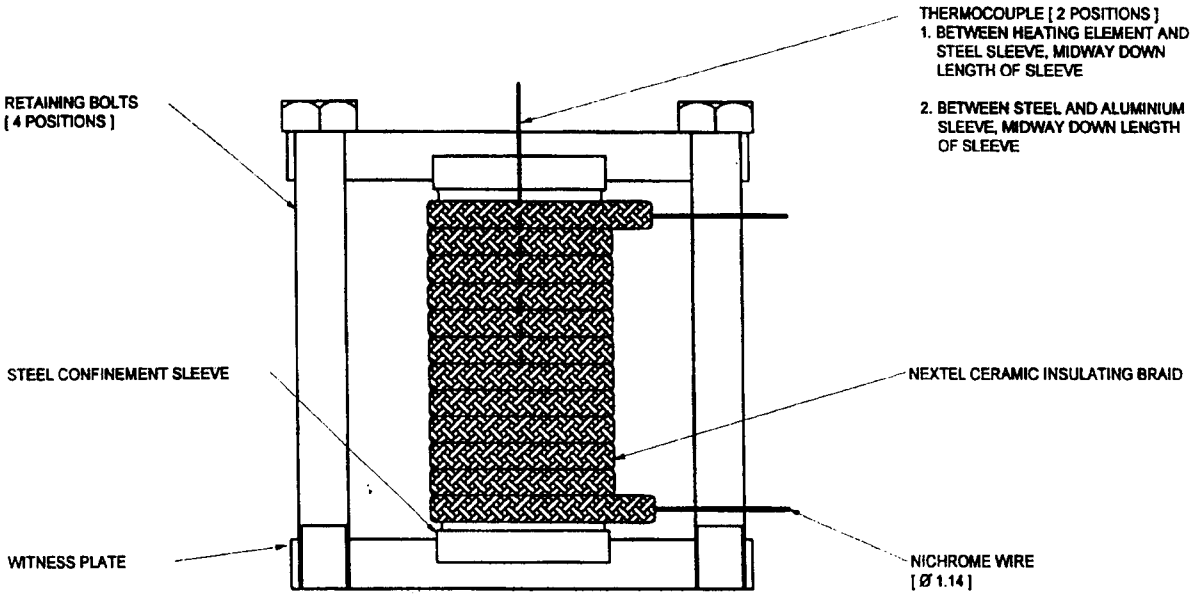


FIGURE 3 - ASSEMBLY, SHIWING HEATER

ANNEX C-2 to
STANAG 4491
(Edition 1)

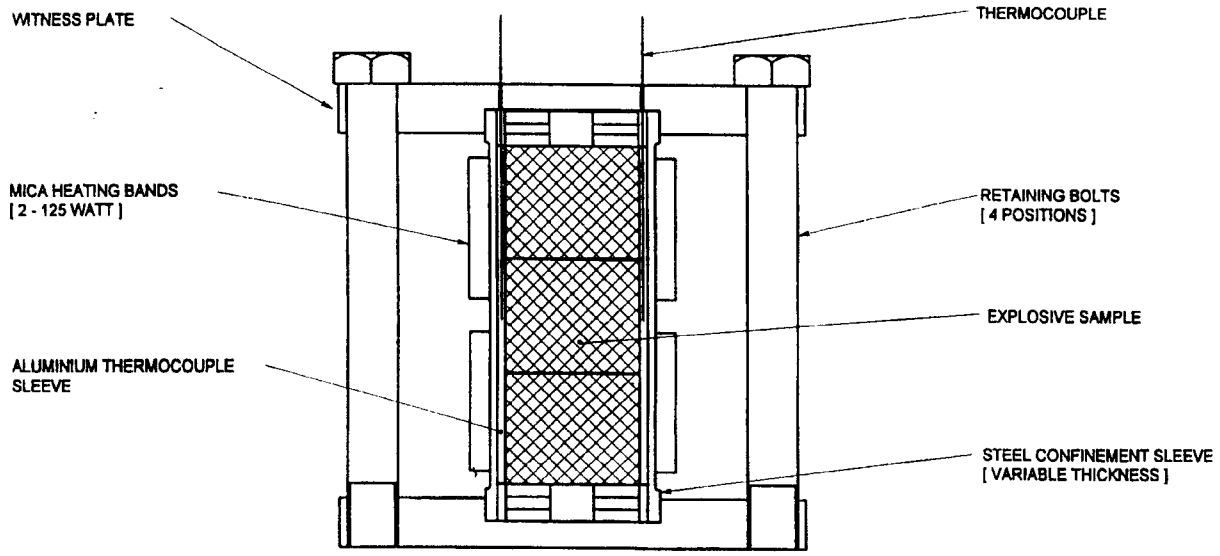
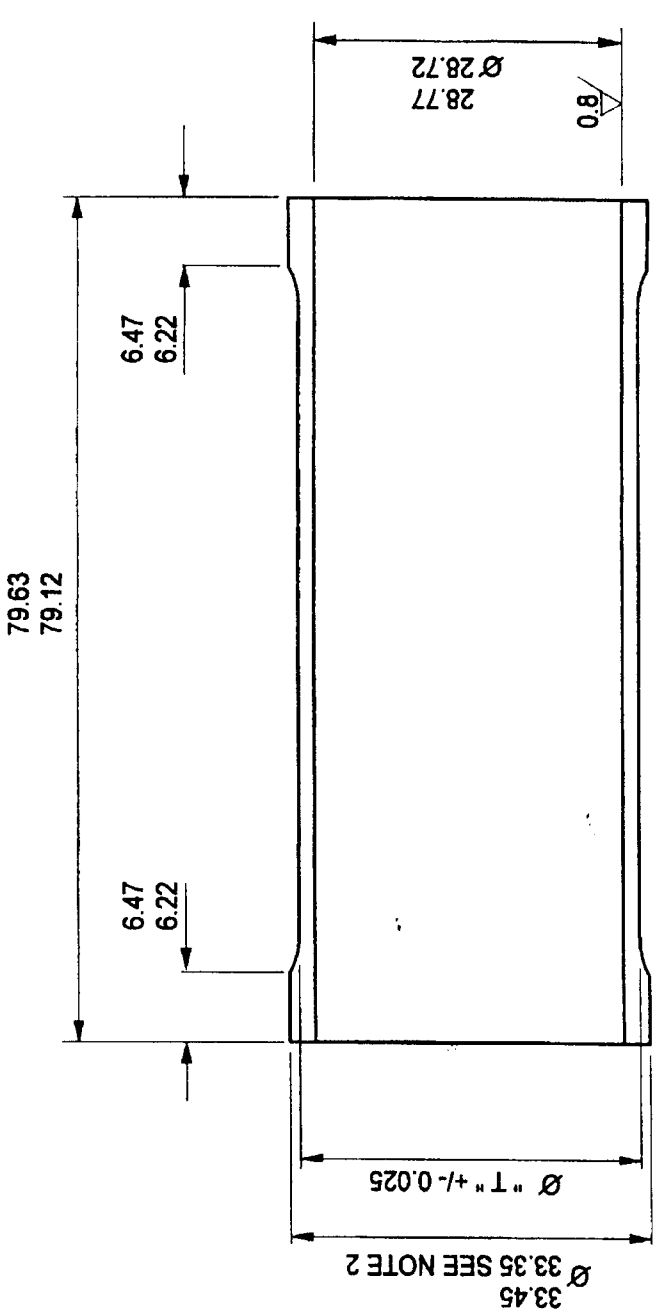


FIGURE 4 - ASSEMBLY SECTIONED VIEW



SECTION ON CENTRE LINE

DIMENSIONS IN mm

PC#	Ø"T"
T15	29.46
T30	30.22
T45	30.98
T60	31.75
T75	32.51
T90	33.27
T105	34.06
T120	34.79

NOTES:

1. MATERIAL:
   MILD STEEL (SEAMLESS)
   Y. S. 544.68MPa +/- 0.03MPa
   U. S. 620.52MPa +/- 0.03MPa
   ELONG. 14% +/- 2%

2. EXTERNAL DIAMETER
   FOR T105 & T120 IS
   34.92 +/- 0.05

FIGURE 5 - STEEL SLEEVE

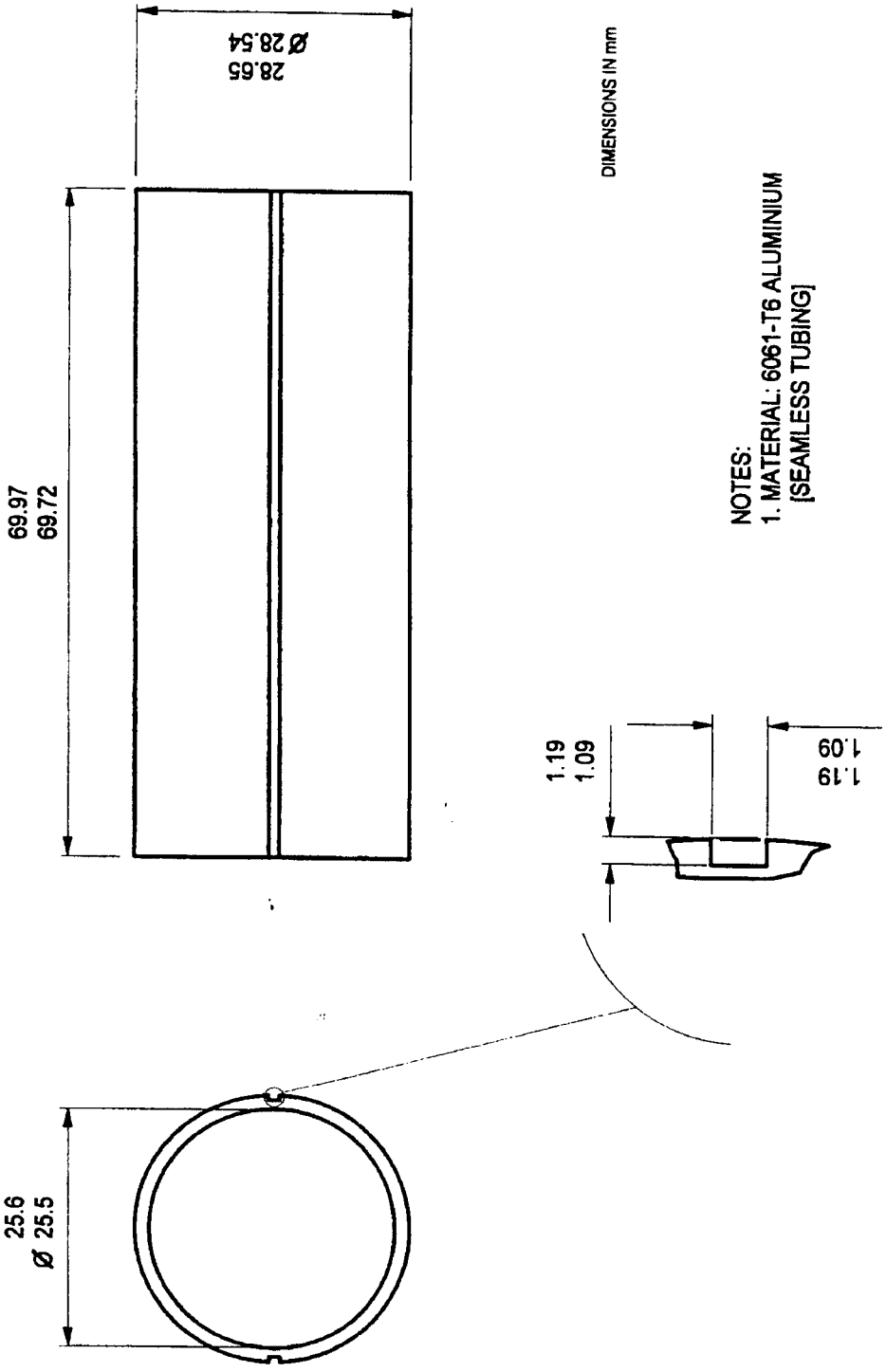
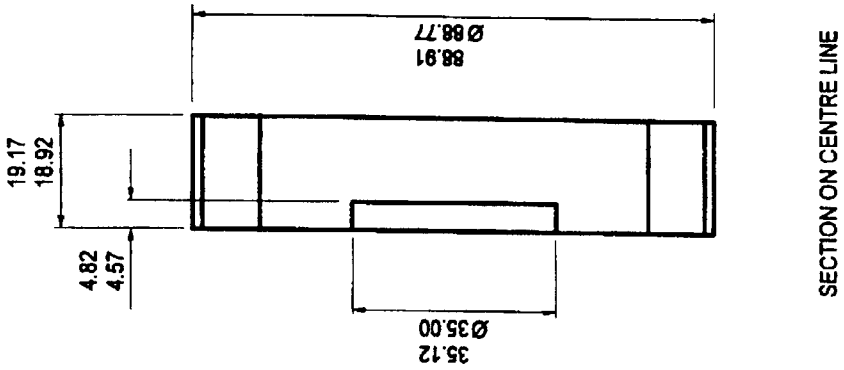
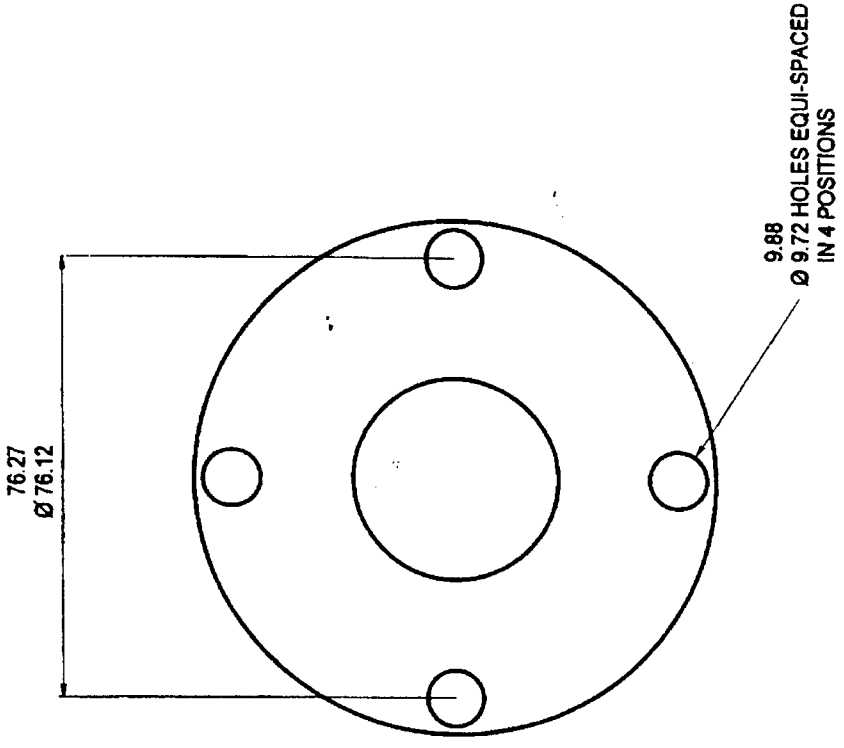


FIGURE 6 - ALUMINIUM SLEEVE



DIMENSIONS IN mm



NOTE:

1. MATERIAL: MILD STEEL
2. EVERY OTHER ENDPLATE WILL BE TAPPED WITH M8x1.25 OR [3/8"-16-UNC] THREADS
3. REMOVE ALL SHARP CORNERS AND EDGES WITH A MAXIMUM 1.2 RADIUS OR CHAMFER, EXCEPT WHERE SPECIFIED

FIGURE 7 - WITNESS PLATE

Test Explosive	Average Density (kg/m³)	Steel tubes wall (mm)	External cook – off temperature (°C)	Internal cook – off temperature (°C)	Reaction Category
CH - 6	1.65	0.375	510	354	Explosion
CH - 6	1.65	0.750	621	338	Detonation
PBXN - 5	1.79	1.125	627	366	Burn
PBXN - 5	1.79	1.500	518	354	Deflagration
PBXN - 5	1.79	1.500	568	318	Burn
PBXN - 5	1.79	1.875	510	343	Explosion
PBXW - 11	1.79	2.250	538	366	Detonation
PBXW - 11	1.79	1.875	554	316	Burn
PBXN - 5	1.79	2.625	685	307	Deflagration
PBXN - 5	1.77	2.625	649	379	Burn
PBXN - 5	1.77	3.000	602	352	Deflagration
Comp A – 5	1.65	0.375	643	402	Detonation
Comp A – 5	1.65	0.750	579	318	Detonation

TABLE 1 – VCCT (FCO) RESULTS

C3 - TUBE TEST (FCO AND SCO)

1. SCOPE

The apparatus and test procedure herein described is suitable for the measurement of the explosiveness of solid energetic materials.

2. PRINCIPLE

A sample of explosive, confined in a steel tube, is heated by means of an external fire for FCO or by an electrical winding for SCO. The degree of tube fragmentation is used to assess the relative explosiveness of the composition under test.

3. APPARATUS

The assembled test vehicle is shown schematically in Figure 1. It consists of a solid cold drawn mild steel tube, of internal diameter 30 to 50mm, length 200 to 254mm and wall thickness 4 to 6mm, sealed by threaded end caps. The end caps must be as strong or stronger than the tube so that in low explosiveness events the tube wall fails before the end caps fail.

4. SAMPLE PREPARATION

The tube and end caps are weighed and then whenever possible, the explosive charge is filled directly into the test vehicle. Pressed or machined pellets can be loaded separately but they must be a good fit in the tube. The filling weight is recorded.

5. TYPES OF REACTION

Results are tabulated as shown in Table 1. The number of body fragments provides the most useful indication of the explosiveness of the test material and this number defines the reaction category. End cap fragments do not count as body fragments.

6. TEST PROCEDURE

Firings should be carried out in a facility capable of retaining at least a representative sample of the fragments produced. For FCO the filled test vehicle is supported over either a tray containing 2 litres of petrol or a wood fire. A proven method to produce a wood fire which has a balanced fuel / air ratio and therefore produces less smoke is to construct a lattice from air dried pieces of wood each not more than 50 mm thick and spaced at about 100 mm intervals. The fuel is remotely ignited and the time from ignition to event is recorded. When all signs of fire have disappeared and a suitable cooling off period has elapsed, the remains of the vehicle are collected along with any unreacted explosive. For SCO the electrical heater winding is used. The number of steel body fragments and the total number of fragments are recorded. A minimum of three trials are undertaken for each explosive under test.

7. REPORTING OF RESULTS / DATA-SHEET

Results are tabulated as shown in Table 2. The number of body fragments provides the most useful indication of the explosiveness of the test material.

8. REFERENCE DATA

These are shown in Table 3.

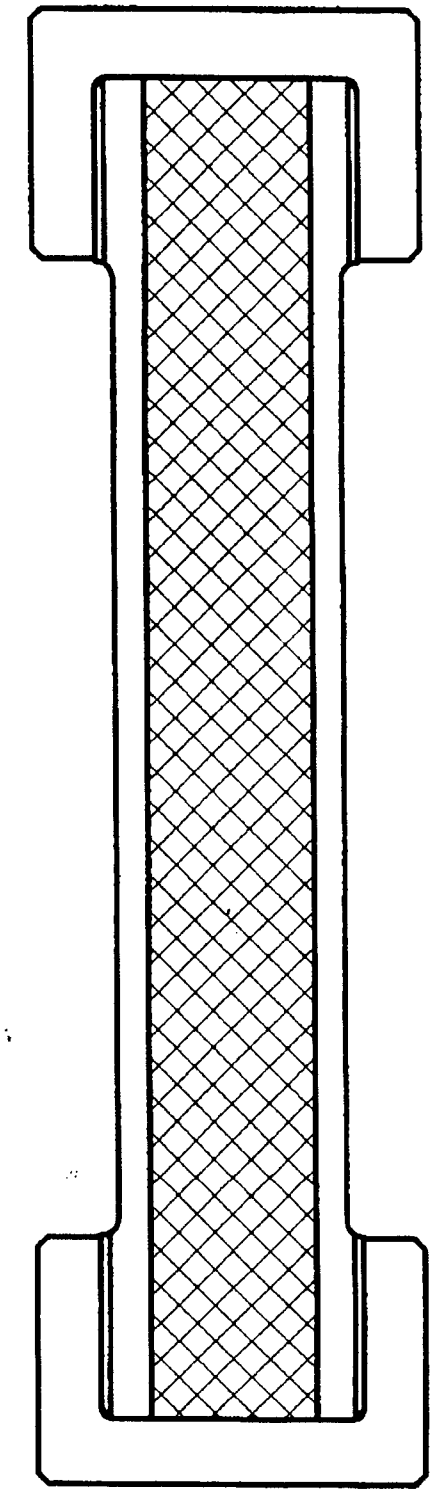


FIGURE 1 - FILLED TEST VEHICLE

Category	Reaction Description	Observation
0	No reaction	Internal inspection.
0/1	Burning / decomposition	No disruption of test vehicle.
1	Deflagration	Test vehicle ruptured but one fragment approximates to initial weight.
2	Explosion	2 to 9 test vehicle body fragments.
3	Detonation	10 to 100 test vehicle body fragments showing evidence of detonation.
4	Detonation	>100 test vehicle body fragments showing evidence of detonation.

TABLE 1 : DESCRIPTION OF REACTION CATEGORIES

Explosive Formulation: TNT/HNS 99.5 / 0.5

Filling Method: Open cast.

Filled Density: 1590 kg/m³

Round No	Trial Date	Recovered Fragments			%Filling Recovered	Reaction category	Time to Event (s)	Comments
		Total No	Body no	% Weight				
1	12/7/89	111	98	80	0	4	408	Venting prior to event
2	ditto	53	46	80	0	3	367	
3	ditto	124	108	55	0	4	447	
4	ditto	52	43	85	0	3	301	
5	ditto	74	64	95	0	3	315	
6	ditto	83	77	60	0	4	255	
7	ditto	58	51	95	0	3	236	
8	ditto	158	148	75	0	4	357	
9	ditto	142	136	85	0	4	304	
10	13/7/89	95	44	95	0	3	302	

TABLE 2: TUBE TEST (FCO) RESULTS FORMAT

Composition	Reaction Category, (No. of Events)	Average No. of Body fragments	Average Time to Event (s)
HMX/TNT 85/15	3(4), 4(6)	> 100	174
HMX/PU 85/15	1(10	1	171
RDX/Wax/A1/PIB 71/7/20/2 +0.5% Carbon black	1(4), 2 (6)	1	163
TNT/HNS 99.5/0.5	3(5), 4(5)	55 / > 100	329

TABLE 3: TYPICAL TUBE TEST (FCO) RESULTS

RATIFICATION AND IMPLEMENTATION DETAILS
STADE DE RATIFICATION ET DE MISE EN APPLICATION

EDITION: 1

NATION	NATIONAL RATIFICATION REFERENCE DE LA RATIFICATION NATIONALE	NATIONAL IMPLEMENTING DOCUMENT NATIONAL DE MISE EN APPLICATION	IMPLEMENTATION / MISE EN APPLICATION					
			INTENDED DATE OF IMPLEMENTATION/ DATE PREVUE POUR MISE EN APPLICATION			DATE IMPLEMENTATION WAS ACHIEVED/ DATE REELLE DE MISE EN APPLICATION		
			NAVY MER	ARMY TERRE	AIR	NAVY MER	ARMY TERRE	AIR
BE	GSA 01/77993 of/du 23.08.01							
CA	2441-4491 (A/DAPM 4-3) of/du 26.11.01	STANAG	01.02	01.02	01.02			
CZ	6/2-48/2001-1419 of/du 22.08.01	Czech Defence Standard No. 137601		09.01	09.01			
DA	FKO MAM3 204.69-S4491 0008509-003 of/du 14.02.01	STANAG	09.02	09.02	09.02			
FR								
GE								
GR								
HU								
IT								
LU								
NL	M2001002221 of/du 09.05.01	STANAG				09.02	09.02	09.02
NO	NSA-14/01 HQDEFCOMNOR/Naval staff/ST 4491 of/du 19.12.01	STANAG						
PL								
PO								
SP								
TU								
UK	DEF061/2/13/01 of/du 04.01.01	STANAG	09.02	09.02	09.02			
US *	Memo, OUSD(A&T) of/du 07.11.01	MIL-STD-1751	11.01	11.01	11.01			

* See reservations overleaf/voir réserves au verso
+See comments overleaf/Voir commentaires au verso
X Service(s) implementing/Armées mettant en application

STANAG 4491
(Edition 1)

RESERVATIONS/RESERVES

UNITED STATES	Test C3 - Table 2 – The reaction severity should be influenced by the degree of containment. US will add a column to Table 2 documenting the test vehicle (i.e. ID, length, tube thickness, steel type).
ETATS-UNIS	*Le degré de confinement doit avoir une incidence sur le niveau de la réaction. Les Etats-Unis ajouteront au tableau 2 une colonne donnant des précisions sur la maquette (à savoir le diamètre intérieur, la longueur, l'épaisseur du tube, le type d'acier).*